

Rats and Plague.

BY C. B. KLOSS.

The intimate connection that exists between plague and rats is a matter to which very little attention seems to have been paid in the Straits Settlements beyond the organised destruction of the animals on a small scale by the Municipal bodies of Singapore and Penang, for if any researches have taken place the result has not been made public. The question does not affect the Federated Malay States to quite the same extent, as its towns are not so directly connected with the birth-places of such epidemics as are those of the Colony.

The matter has, however, excited considerable interest in India in the last few years and the Indian Museum has published the outcome of investigations, by Dr. W. C. Hossack of the Calcutta Plague Department and of Surgeon-Captain R. E. Lloyd of the Indian Marine Survey.* The Bombay Natural History Society deals with the subject in one of its journals† and Indian Municipalities, have also issued Plague Reports but is the publications of the India Museum that are noticed here.

In a preliminary pamphlet Dr. Hossack gives some instructions for collecting specimens of rats for study which could easily be improved on and follows these, for the benefit of the inexperienced observer, with "a succinct account of the rats of

* W. C. Hossack, M. D. Aids to the Identification of Rats connected with Plague in India with suggestions as to the Collection of Specimens. Published by the Trustees of the Indian Museum, 1907. Price 8 annas. An account of the Rats of Calcutta, Memoirs of the Indian Museum, Vol. I, No. 1, Calcutta 1907. Price 1 rupee 8 annas or with plates 5 rupees 8 annas.

Captain R. E. Lloyd, D. Sc., I. M. S. The Races of Indian Rats Records of the Indian Museum Vol. III, Part 1. Calcutta 1909 Price 2 rupees.

† Captain Liston, I. M. S., Plague, Rats and Fleas, vol. XVI. p. 253.

common occurrence and likely to prove of interest and importance to the practical epidemiologist" in Calcutta: these seem to consist of three species of true rats and one species of bandicoot-rat. The names of other species are noted but they are not considered to be of any practical importance to the Indian worker and the little house-mouse goes into the same category. It is pointed out that the Musk-rats or Musk-shrews (*Crocidura murina* and *C. caerulea*), "Tikus turi" and "Chenchurot" of Malays, are not rodents at all but insectivores, and though dwellers in cellars and drains do not appear susceptible to plague. The descriptions given are broad but probably sufficiently detailed for success in identification when the limited number of species that are likely to come before the sanitary officer is borne in mind.

Dr. Hossack's next essay consists of an illustrated account of the rats of Calcutta. Though the author admits that he was an absolute tyro for whom it was difficult to discuss the present state of systematic zoology dealing with the subject, he nevertheless ventures more than once to criticise the work of systematists. This is also the case with Captain Lloyd who is far from successful in his efforts in this direction. To criticise the validity of insular Malayan species as Dr. Hossack does is gratuitous, since they are a class of which he, a worker in a great land area, whose acquaintance with the *Murinae* is very limited and admittedly recent, is entirely ignorant.

It is perhaps unfortunate that both authors take for the basis of their work Mr. Oldfield Thomas's then epoch-making—and still most valuable—paper of 1881 on the Indian species of the Genus *Mus*,* not appreciating the fact that the increase of knowledge in the last quarter of a century has brought to light many new facts with the necessary result that a commensurate alteration of opinion has taken place—a state of affairs that Mr. Thomas would probably be the first to admit: for instance; he has recently divided *Nesokia* which he then regarded as only a sub-genus of *Mus* into three independent

* Proceedings of the Zoological Society of London for 1881, pp. 521—557.

genera. These are recognised, at least by Captain Lloyd, but throughout the reports we find a blind belief in the pronouncements of Mr. Thomas as a repudiation of the findings of all other systematic workers. Dr. Hossack has omitted to place in his list of Indian rats the names of *Mus mettada* and *Mus humei*: as the one is included by Mr. Thomas in the paper noted above and the other is described by him, it is curious that this author does not find them acceptable!

The bulk of Dr. Hossack's work which is, as far as it goes excellent, is taken up with an account of those rats of Calcutta which he has found to be connected with plague; these are *Mus decumanus*, Pallas, *Nesokia* (*Gunomys*), *bengalensis*, Gray and Hardw., various forms of *Mus rattus* Linn., and *Nesokia* (*Bandicota*) *nemorivaga*, Hodgs.

Amongst the animals brought to him the last was very rare and *Mus rattus* only formed about 15 per cent of the total. In connection with the others an interesting fact was noted: that while in the northern native area of Calcutta, where grain stores and huts abound, *N. bengalensis* and *M. decumanus* occurred or rather were caught, in the ratios of 60 and 26 per cent of the total; yet in the central European portion of the city these proportions were strikingly reversed, *M. decumanus* forming 51 per cent and *N. bengalensis* only 37 per cent of the catch.

Careful dates for distinguishing the immature from the adult animal are given; a key is furnished for distinguishing the various species together with elaborate descriptions and measurements of each and a supplement contains coloured illustrations of the plague rats together with figures of skulls, teeth and feet.

Surgeon-Captain Lloyd's paper bears the unfortunately ambitious title of "The Races of Indian Rats," though it is quickly obvious that the author has an acquaintance with but a small section of them. While no doubt where those connected with plague are concerned, he is on safe ground, such is not the case when he deals with the genus *Mus* as a whole and the confusion then brought about seems to be almost entirely

due to his total non-acquaintance with the group of non-rattus rats with bicolored tails and spiny coats; and to failure in grasping the fact that these animals *are never found in towns*. He thus mistakes for these latter the sports which occur so frequently amongst the *rattus* group.

The author's faulty knowledge of the Eastern portion of the genus *Mus* is illustrated by the statement (p. 9) that "over ninety species of rats have been described from the oriental region which are indisputably closely allied to *Mus rattus*." This is a decided error: less than one-third of the names in the list he refers to, including synonyms, can be attached to animals of the *rattus* group, and the remainder are nearly all those of members of groups whose centres of distribution are outside the Indian sub-region altogether—if the rural areas therein have been thoroughly worked,—and on its borders are represented by very few species only; i.e., *Mus jerdoni* and perhaps *Mus niveiventer* from the Himalayas with *Mus bowersi* from Manipur and Yunnan, and *Mus berdmorei* from Manipur Tenasserim.

On p. 10, *Mus jerdoni* is rightly excluded from the *rattus* group, yet on pp. 93 and 94 it is claimed "on sure evidence" as one of four established races of the *rattus* type." The reason for this laying down of the law seems to have arisen from the fact that several animals with bicolored tails—evidently abnormal examples of *Mus rattus*—were caught in houses in Naini Tal and—because of their albinistic traits—regarded as example of *Mus jerdoni*. Had it been understood that this latter with many others of its type is a rat of purely rural habitat, such confusion would have been impossible.

The bicoloration of the tail is not, as is stated on p. 89, "the all-important feature in the description of many species of the *rattus* group," but it is of secondary importance in descriptions of non-rattus species and in separating these latter from the others. Normal *rattus* rats do not have bicoloured tails, though *Mus vicereis*, Bonhot, appears to be an exception.

The bulk of the paper is concerned with descriptions of the rats obtained in the towns of India in connection with plague investigations but its value is largely obscured by the

great amount of attention that is given to the consideration of "sports," and by too frequent references to those species of which the author has no personal acquaintance—the non-*rattus* rats. We are shown too at great length that which we know already, viz., that semi-domesticated rats, or rather, rats living in a state of commensalism, are liable to great variation, and that *Mus rattus* in particular is an enormously plastic species. In spite of this and though the unwisdom of naming new species from this group then living under artificial conditions is admitted, publicity is given to a description, under the name *Mus brahminicus* (now of Lloyd) of a New Species (?) which appears to be founded on a couple of piebald semi-albino house rats!

It is not until we reach the section devoted to Burmah that rats approximating to Malayan forms come under consideration.

It is noted, and this must be regarded as a concession to the systematist, that amongst many hundreds of Burmese *rattus* examined, not one was found which in colour and size resembled any of the Indian rats but that of the two species present the larger—a white-bellied brown-backed form—seems most nearly to be matched by *Mus jalorensis*, Bonhote, from the Malay Peninsula.

In the Peninsula, however, *Mus jalorensis*, although not found as a rule far away from the neighbourhood of man is a country rat and the common house rat is a different animal with well defined characters.

The small race is *Mus concolor* which, though a somewhat variable animal within limits, is a very distinct species. It formed at least 50 per cent of the total rats of Rangoon and at least 75 per cent of the true house rats: and here again, though, not so numerous in Malaya, it is of very common occurrence both in town and country. It has not been recorded from India.

It is interesting to compare with the Indian returns the occurrence of the various species as noted by the plague investigators in Rangoon. *Mus rattus* together with *Mus concolor*

formed 72 per cent, *Gunomys* (*Nesokia*) species 21 per cent and *Mus decumanus* only 7 per cent of the total brought to them. In India the former formed 15 per cent of the total, *Nesokia* species 48 per cent and *Mus decumanus* 37 per cent. In Calcutta the latter was most numerous in the European quarter: in Rangoon it chiefly came from the river-side buildings. So far as investigations have been carried on the house rats of Rangoon and those of other Burmese towns are the same.

Noteworthy is the record for the first time from Burmah of a bandicoot-rat that has recently been separated from the Indian form *Gunomys bengalensis*, and described, from Penang specimens under the name of *Gunomys varius*. The two species overlap in Rangoon where they have been captured in the ratio of three to two.

The conclusions of the Bombay Plague Commission are quoted. "With regard to the epizootic amongst rats the following conclusions may be formulated:—

(1) *Mus decumanus* and *Mus rattus* are equally susceptible to plague.

(2) The incidence of plague is twice as great on the *decumanus* population as on the *rattus* population.

(5) The *rattus* epizootic is directly attributable to the *decumanus* epizootic" and it is pointed out that the first and second statement are reconciled and explained by the fact that *Mus decumanus* on an average harbours twice as many fleas as *Mus rattus* and we are further warned that in ports where *Mus decumanus* is firmly established extra danger is always to be looked for from communication between ship and shore since it is the commonest of sea-going rats.

Captain Lloyd has been criticised but it is to be said that, in spite of faulty grasp of the subject on its zoological side, when he ceases to treat and touch on "sports" and the non-urban division of the *Murinae* his report is most informing and interesting.

So far as the Malay Peninsula is concerned with the spread of plague epidemics the local animals we must consider in the connection are primarily:—

(1) *Mus decumanus*, Pallas. The Brown or Norway Rat.
 (2) *Mus griseiventer*, Bonhote. The Malay House or Roof Rat.

(3) *Mus concolor*, Blyth. The Little Rat.

(4) Of less importance are *Gunomys varius*, Thomas. The Eastern Bandicoot-rat.

(5) *Gunomys varillus*, Thomas. The Little Bandicoot-rat.
Mus musculus, Linn. The Common Mouse, is probably harmless; it is in any event so rare as to be negligible and the latter may also be said, with regard to their occurrence in towns, of *Mus jalorensis* Bonhote, a whitish-bellied member of the *rattus* group.

Though one or two Indian squirrels are regarded with suspicion, Malayan squirrels—owing to their different habits—need not be taken into account at all.

The species of bandicoot-rats listed above have recently been described from Penang specimens: *Gunomys varius* differs but slightly from *G. bengalensis* Gray, the well-known Indian species and *G. varillus*, as its name indicates, is a small form of *G. varius*. The latter has lately been taken in large numbers in Rangoon and has probably been carried thence to Penang in rice-ships. The bandicoot-rats are certainly introduced species in the Peninsula, they seem to have been recorded hitherto only from Penang but I am aware of their occurrence in Singapore though I have never examined specimens. Cantor in 1846 (J. A. S. B. vol. XV), recorded *Mus bandicota*, Bechstein, (= *Bandicota nemorivaga*, Hodgs.) from Penang and the Peninsula and this species possibly occurs in Singapore also.

Though the bandicoot-rats are known vehicles of plague hosts, it is probable that they exist in such small numbers locally as to be of minor importance.

Mus decumanus is a ship rat which scarcely occurs outside large ports (Singapore, Penang, Malacca and Port Swettenham) though I have taken a few individuals in Johore Bahru. It is one of the most dangerous species owing to the large number of parasites it harbours. And here it may be pointed out that just as the *Anopheles* mosquito is the conveyer of malaria, and the

Stegomyia mosquito of yellow fever so the rat-flea *Pulex cheopis* is the disseminator of plague which is spread so far as is known at present by its agency alone. The simplest method of eliminating danger from the flea is to destroy the rat on which it exists and of which it is carried about.

Mus griseiventer, a somewhat aberrant member of the *rattus* group approaching *M. decumanus* in the harsh nature of its pelage and size of feet, is the commonest house-rat throughout the Malay Peninsula—in the southern half at any rate. It is found everywhere in the neighbourhood of man as is also *Mus concolor*, a diminutive form of *Mus rattus* with a very spiny coat.

In external appearance *Gunomys varius* and *Mus decumanus* seem somewhat alike on superficial examination and both attain a head-and-body length of nine to ten inches, the latter sometimes reaching nearly a foot. There are however many points of difference.

In *Gunomys varius* the pelage is thin and meagre in quantity, especially on the abdomen, and cold in tone, the upper surface being a mixture of black and buff. Its tail is uniformly dark and clad with dark hairs and is somewhat short (about 80% or less of the length of head and body). Its feet have dark hairs on their upper surfaces.

Mus decumanus is fairly thickly clad with fur of a warmer colour, that of the back being mingled sooty and ochraceous. Its tail is flesh-coloured on the basal half of the under surface and this area produces pale hairs which contrast with the brown hairs of the brown upper surface: it also nearly approaches (90 per cent) the length of the head and body. The feet are flesh coloured with white hairs on the upper surface. The under surfaces of both animals are of a silvery or smoky gray.

A differentiating character for the genera of *Mus* and *Nesokia* (*Gunomys*) given by Stanford and others is that the upper incisors of the latter are, on the outer surface, sculptured with faint longitudinal grooves while the front teeth of *Mus* are smooth. Dr. Hossack has, I think rightly, pointed out that this

is not strictly the case: yet it may be said that while the grooves of *Nesokia* are most distinct, those of the rats are very ill-defined and visible with the help of a strong lens only.

Another readily observed difference between the two lies in the form of the molars, more especially of the upper series. Those of *Nesokia* are divided transversely into laminae; those of *Mus* sinuously into cusps: these features are shown most clearly when the teeth are worn.

The body of *Gunomys* is stout, that of *Mus* slender; variations that are again strongly emphasized in the skulls, that of the former being short, broad and deep, robust and solid in construction while the latter is elongate, slender, shallow and of a more delicate appearance: in *Gunomys* the nasal bones fall short of, or never project beyond, the front surfaces of the incisors: in *Mus* the nasals are so elongated that if the skull is viewed from above the incisors are completely hidden. Again, viewed laterally, the zygomatic arch of *Mus* is almost in a plane with the alveolar edge of the upper molars, that of *Gunomys* falls far short of this.

A further notable difference which has not before been remarked on may be seen on the outer surfaces of the ascending rami of the jaw bone. Where on the base of attachment of the masseter muscle we find in *Mus* merely a slight tubercle or protuberance, there occurs in *Gunomys* a distinct upward-pointing spine having between it and the surface of the ramus so deep a gap that the spur appears almost as defined as the coronal point or condyle.

Mus validus of which the skull most nearly approaches in form and structure that of *Gunomys* has this tubercle rather more developed than have other rats and in the bamboo-rats (*Rhizomys* Spp.) it is even more exaggerated than in the *Nesokia* group.

The only comparison *Mus griseiventer* needs for our purpose is with *Mus decumanus*. In both the dorsal pelage is harsh and wiry but not essentially spiny and the abdomen grey or drab coloured. The upper colouring of the former is somewhat warmer, the tail is dark throughout and slightly

longer than the head and body, the length of which scarcely ever exceeds seven inches, and the feet are brownish.

From all the above *Mus concolor* differs in its small size, head and body being about five inches and the tail half an inch more, and its soft dense upper fur which however is thickly set with flattened grooved spines.

Beyond the species mentioned above there are hardly likely to be others which come within the vision of our local epidemiologist yet though plague is perhaps less to be feared in Malaya than in certain other countries an exact knowledge of the agents disseminating it should be in his possession: it is to be hoped, however; if our Sanitary officers should undertake investigation to this end, that they will have associated with them a colleague acquainted with the zoological side of the subject that their work may be free from that vagueness and uncertainty so frequently obvious in the reports now noticed.

C. B. KLOSS.